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SCIENCE AND PSEUDO-SCIENCE.

Genèse de la Matière et de l'Energie—Formation et Fin d'un Monde. Par A. Despaux, Ingénieur des Arts et Manufactures. Pp. 232. (Paris: Félix Alcan, 1900.)

THERE are two classes of writers whose works on scientific subjects possess little or no intrinsic scientific value. The first consists of those who, carrying their distrust of rational authority even beyond the bounds of sanity, run headlong against established modes of thought, and lose themselves in a maze of paradox. To the second class belong authors who, while they show no outward disrespect for the accepted elements of orthodox philosophy, have neither the patience nor the ability to pursue the arduous paths which lead to truth, but with a courage born of want of knowledge of the real difficulties take their own way under the treacherous guidance of blind intuition.

The rapidity of their progress is astonishing, but whether it has an end worth reaching may in general be questioned. The cautious critic finds these excursions difficult to follow, and he therefore has a natural tendency perhaps to do them less than justice. But it may be proper to insist here on the fact that it is of little use even to blunder on a truth unless care be taken to free it from all that is doubtful, and to place it in a convincing light. Failure in this respect constitutes a serious objection to the intuitive method as exemplified by the book under review.

To the representatives of intuitive as opposed to more scientific methods the borderland of the known in science offers great opportunities. In particular, the problems of cosmogony and molecular physics seem to possess a singular fascination for this type of mind. It seems to matter little that these problems present the very greatest difficulties, of which the mere exact formulation is not to be undertaken lightly, and which seem to demand for their solution a mastery over so wide a range of experimental fact and so great a power in the use of mathematical analysis as to have baffled hitherto the most gifted investigators. Indeed, it is being realised more and more how inadequate is the store of facts and how great the need, probably, of an entirely new machinery of analysis. And yet how petty are our discussions, for instance, of the propriety of employing the principle of Action, how futile our doubts about the appropriateness of certain mechanical models to represent ethereal operations! Our intuitive philosophers, as we have said, are ready at one bound to surmount such pedantic obstacles, and why should we not follow them?

The mere title of this book seems to give some justification for suspecting that M. Despaux is not quite innocent of those heretical methods to which we have alluded. Within the modest compass of 232 octavo pages he attempts to explain the origin and nature of matter and energy, the constitution of the molecule, gravitation, many fundamental questions in physics, such as radiant energy and electricity, and, in addition to all this, the formation of the solar system. The scheme is so ambitious that the conclusion seems inevitable that the author has failed to realise the stupendous difficulties to be overcome. And this impression, which is fully confirmed on reading his book, makes it impossible to consider it very seriously. The phenomena to which the author refers are only such as must be well known even to the most elementary student of physics, and if M. Despaux has any claims to be considered a mathematician, his modesty has led him to conceal the fact most scrupulously.

The reader of the book quickly finds that in order to follow the author closely he must gain some idea of M. Despaux' views on the nature of the ether and of the atom. The former he considers as the vehicle necessary for the transference of energy in an undulatory form. Up to a certain point his notions of wave motion are clear and well expressed. Unfortunately, they are as restricted as those of a century ago, and are in effect confined to waves of the condensational-rarefractional type. The result is that the author describes the ether as a discontinuous medium, possessing in some measure the qualities of a gas, thus ignoring all the difficulties which arise from the phenomena of polarisation. On the other hand, his general views on the meaning of action at a distance, and on the ether as the true energy medium, are much more satisfactory and consistent with modern ideas. It is more difficult to follow M. Despaux' suggestions as to the nature of the atom. We gather that there is an essential unity between all kinds of matter, and that all atoms are intrinsically alike. They are the seat of kinetic energy, and appear to be differentiated only by their particular modes of motion. The energy gives rise to vibrations of two types of which one becomes apparent in the form of radiant energy, while the other causes the effect of mutual gravitation and chemical affinity. But lest we should misrepresent his thoughts, we may quote M. Despaux' own words—

"La gravitation est due à la rotation hélicoïdale des atomes ou molécules qui produit une translation dans l'éther; sans rotation, pas de gravité, les corps seraient sans poids, sans chaleur, sans couleur, . . . Ce qui caractérise la matière, c'est en effet le mouvement des atomes bien plus que les atomes eux-mêmes centres de ces mouvements. . . . En résumé, contrairement aux idées reçues, nous estimons que la masse d'un corps dépend moins du nombre des molécules que de leur vitesse de rotation.—Toutes les energies mettant en jeu les attractions et les répulsions sont de même nature que la gravitation" (pp. 94, 95).

Now the implied connection between gravitation and heat is as repugnant to our ideas as the caloric theory of heat itself; for the former involves an identification o mass with energy which is as objectionable as the confusion of a form of energy with matter in the latter. The grounds of objection are, in fact, precisely the same in both cases. The origin of the heresy is to be found in M. Despaux' incapacity to realise the meaning of mass as a distinct entity. He professes carefully to eschew all arguments which appear to him of a metaphysical nature, and yet fails to see that the discussion of fundamental physical conceptions really belongs to the domain of metaphysics. It is distinctly a pity that he has virtually exceeded the limits of his purpose, for his qualifications as a philosopher seem to be inferior even to his equipment as a physicist.

It seems idle to pursue the author further in his speculations. Not content with formulating a theory of the operation of nature on the molecular scale, he devotes the last part of his essay to the exposition of his views on the subject of cosmogony. In this he adopts the nebular theory of Laplace as a general scheme, and applies to it the ideas which he has previously developed. He has an explanation to offer of the cases of retrograde motion in the solar system and of other phenomena which have been thought to present difficulties. On these points he apparently satisfies himself, though others, in the absence of rigorous proof, may remain sceptical. It is in reference to a subject of some debate, the ultimate fate of the solar system, in fact, that he offers a novel suggestion, based on his peculiar conception of the atom. As others have supposed, the end must come with the slow dissipation of energy; but, in the system of M. Despaux, this implies the loss, not only of heat, but also of gravitational power in the atom, or, in other words, of weight. The energy passes to the ether, and matter deprived of its chief property becomes immaterial. The world, then, no longer remains as an inert mass, but reaches its dissolution and leaves "not a rack behind." It is true that M. Despaux contemplates a return of the energy to the atom, and the whole process from the birth to the death of the system repeated in an endless cycle. But even he does not venture to describe in any detail how this is to come about.

Enough has been said as to the scope of this book, and some reason has been assigned for considering it unphilosophical in design and unenlightened in execution. But it is not to be thought that the author is an unfavourable example of the class to which he belongs. He expresses clearly and concisely what he has to say; he is respectful to the great workers who have adhered to the recognised laborious paths; and it should not be thought that there are no ideas to be found in his work which are true, though such as are true may generally appear not to be original. Yet, when all that is said, it is difficult to conceive the utility of such a work.

A NEW TEXT-BOOK ON SOUND.

A Text-Book of Physics. Sound. By J. H. Poynting, Sc.D., F.R.S., and J. J. Thomson, M.A., F.R.S., Hon. Sc.D. (Dublin), Hon. D.L. (Princeton). Pp. x + 163. (London: Chas. Griffin and Co., Ltd., 1899.)

THIS volume will be welcomed by those interested in the teaching of physical science, not only on account of its individual merits, but also as the first instalment of a complete treatise on physics now in preparation by the authors. It is intended for the use of students who lay most stress on the study of the experimental part of physics, and who have not yet reached the stage at which the reading of advanced treatises on special subjects is desirable. For this class of students it is important that the mathematics used should be of the simplest. So far as concerns those who are unacquainted with the calculus, this is self-evident; it is, further, none the less true with regard to those possessing some knowledge of the higher mathematics. Unless great care is exercised, the use of the calculus is apt to become so far mechanical that the student may possibly miss many tacit assumptions which it would be advantageous for him to clearly recognise. To all students it is alike of importance that each stage in the reasoning employed should be brought into view as clearly as possible, and subjected to the most searching scrutiny. This can be done, sometimes by the use of comparatively simple analytical and geometrical devices, often by the application of the principles of the calculus developed *ab initio*. The volume under consideration comprises many most successful attempts to apply simple mathematical methods to the solution of important, and sometimes fairly intricate, problems. The investigation of the modes of vibration of a stretched string, on pp. 86–88, is perhaps the least successful effort in this direction; few students would, it may be feared, be able to keep the essential features of the problem clearly distinguished from the number of geometrical and analytical assumptions and approximations involved. The investigation of the same problem from another standpoint, as given on p. 93, is much to be preferred in this respect.

In the first chapter a good account is given of the general nature and characteristics of sound. A simple experiment, due to Prof. Boys, in which the vibratory character of sound in air is made manifest, might perhaps have been mentioned with advantage. A Bunsen flame is burnt near the end of an open organ pipe, and when the latter is sounded the sinusoidal paths of dust particles traversing the flame are readily seen. From a mathematical point of view, it is to be regretted that a solution is not here given of the problem of the motion of a heavy particle, attracted toward a point with a force proportional to its displacement therefrom. If we suppose the particle to revolve in a circular orbit about the point, then it is easily seen that the centrifugal force must be equal to the central attraction exerted. Resolving the instantaneous displacement, velocity and central force parallel and perpendicularly to any given axis, then we have two harmonic motions executed under the actions of forces proportional to the displacement from the centre. Considering only one of these harmonic motions, the value of the kinetic and potential energies at any point may easily be written down, when it becomes evident that their sum is constant. Equating the potential energy at the extremity of an excursion to the kinetic energy at the point of equilibrium, the well-known expression for the time of vibration is readily obtained. It is interesting to note that this graphical solution corresponds to assigning the real part of Ae^{iat} as the value of x which satisfies the differential equation

$$\frac{d^2x}{dt^2} + a^2t = 0.$$

The second chapter commences with a simple theoretical investigation of the velocity of sound in a fluid, and is followed by an interesting and valuable account of the experimental aspect of the same question. In connection with the reflection of sound, the curious musical ring, often heard to follow each footfall when one is walking near palisading, is simply explained, and Lord Rayleigh's theory of whispering galleries is described. The introduction in ensuing editions of a few reproductions of Prof. Wood's photographs of sound waves would enhance the interest of this section. Refraction of sounds by winds and air-layers of different densities is also